SOLID ABSORBERS

1. **Measure equilibrium emittance & check cooling formula**

2. **Check equilibrium emittance well-described by $\beta/(X_o\, dE/dX)$**
   - ***If that's true, know how to describe some arbitrary material***
   - ***Need some lever arm in Z***

3. **Poorish measurement of *dE/dX***
   - **Energy resolution ~ few MeV in 226 MeV *cf* ΔE ~ 10 MeV**
     - **Need track length correction**

4. **No useful measurement of 'Landau' distribution**

5. **May be able to measure X_o from increase in trace emittance ??**

GENERALITIES

- **STEP IV has no RF**
  - **But cooling doesn't need RF**

- **Opportunity to give good workout of cooling formula**
  - **Dependence on:**
    - **Beta**
    - **Material via X_0 and dE/dX**
  - **Also observe growth of L_{canon}**
    - **Absorber should be where B = 0 to avoid growth of L_c**
      - **Compare Flip and Solenoid modes**
- **Study one absorber material in detail**
  - **Measure equilibrium emittance of others**

- **Choose absorber for detailed study in middle of emittance range of beams, i.e. ε_0 ~ 6mm**

HOW TO CHOOSE MATERIALS?

- **Materials should be:**
  1. **Cheap**
  2. **Benign**
  3. **Enough range of *Z* to get useful lever on physics quantities:**
     - **Equilibrium emittance**
     - X_o **(?)**

- **Some estimates follow**

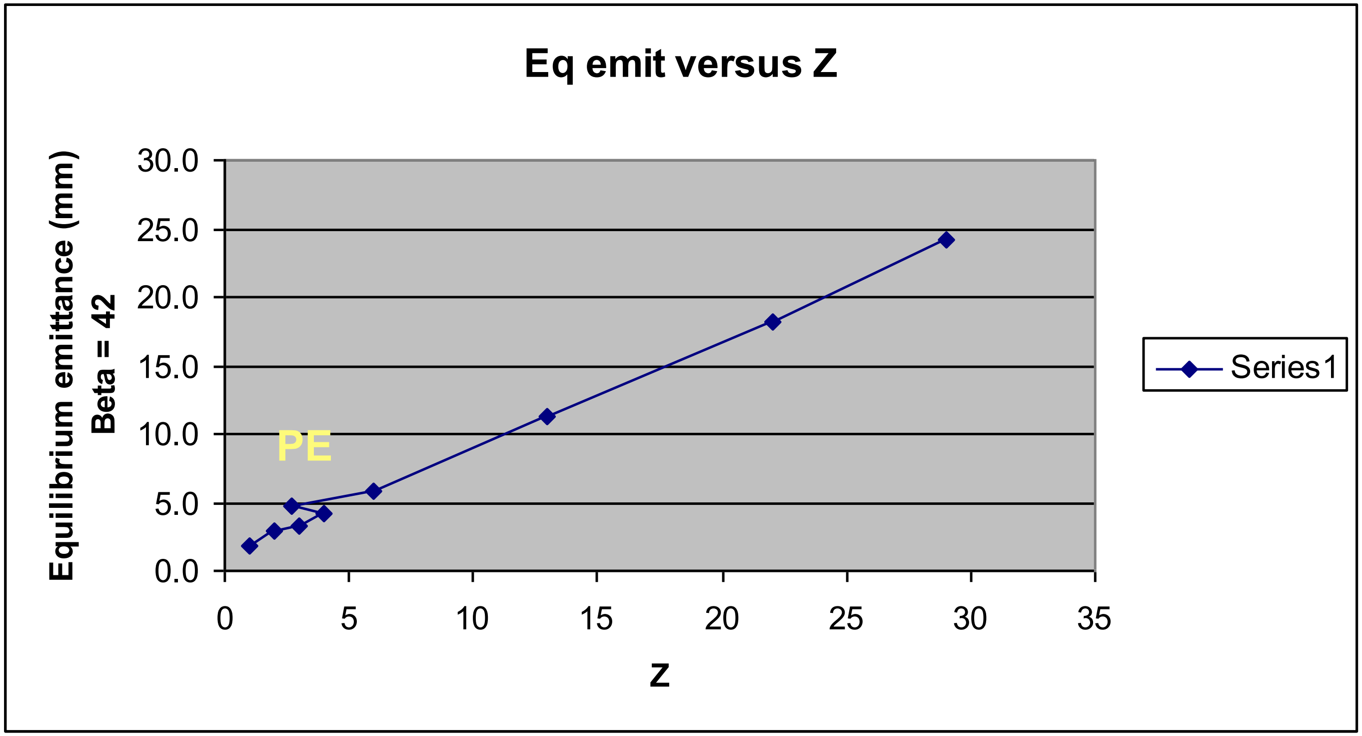
MATERIAL PROPERTIES

	Z	dens gm/cm^3	X0 g/cm^2	dE/dX MeV/(g/cm^2)	t(10 MeV) cm	Mass kg	Eq-emit mm
LH2	**1**	0.0708	61.28	4.034	35.0	1.75	1.8
LiH	**2**	0.82	79.62	1.897	6.4	[illegible]	2.9
Li	**3**	0.534	82.76	1.639	11.4	4.31	3.2
Be	**4**	1.848	65.19	1.594	3.4	4.43	4.2
Poly E	**2.67**	0.935	44.64	2.076	5.2	3.40	4.7
C	**6**	2.265	42.7	1.745	2.5	4.05	5.8
Al	**13**	2.7	24.01	1.615	2.3	4.38	11.2
Ti	**22**	4.54	16.17	1.476	1.5	4.79	18.2
Cu	**29**	8.96	12.86	1.403	0.8	5.04	24.1

Thicknesses chosen to give ΔE ~ 10MeV

All properties straight from PDB

Masses calculated for 300mm diameter = LH_2 absorber
(LiH will be 450mm ➔ Mass = 8.4kg)

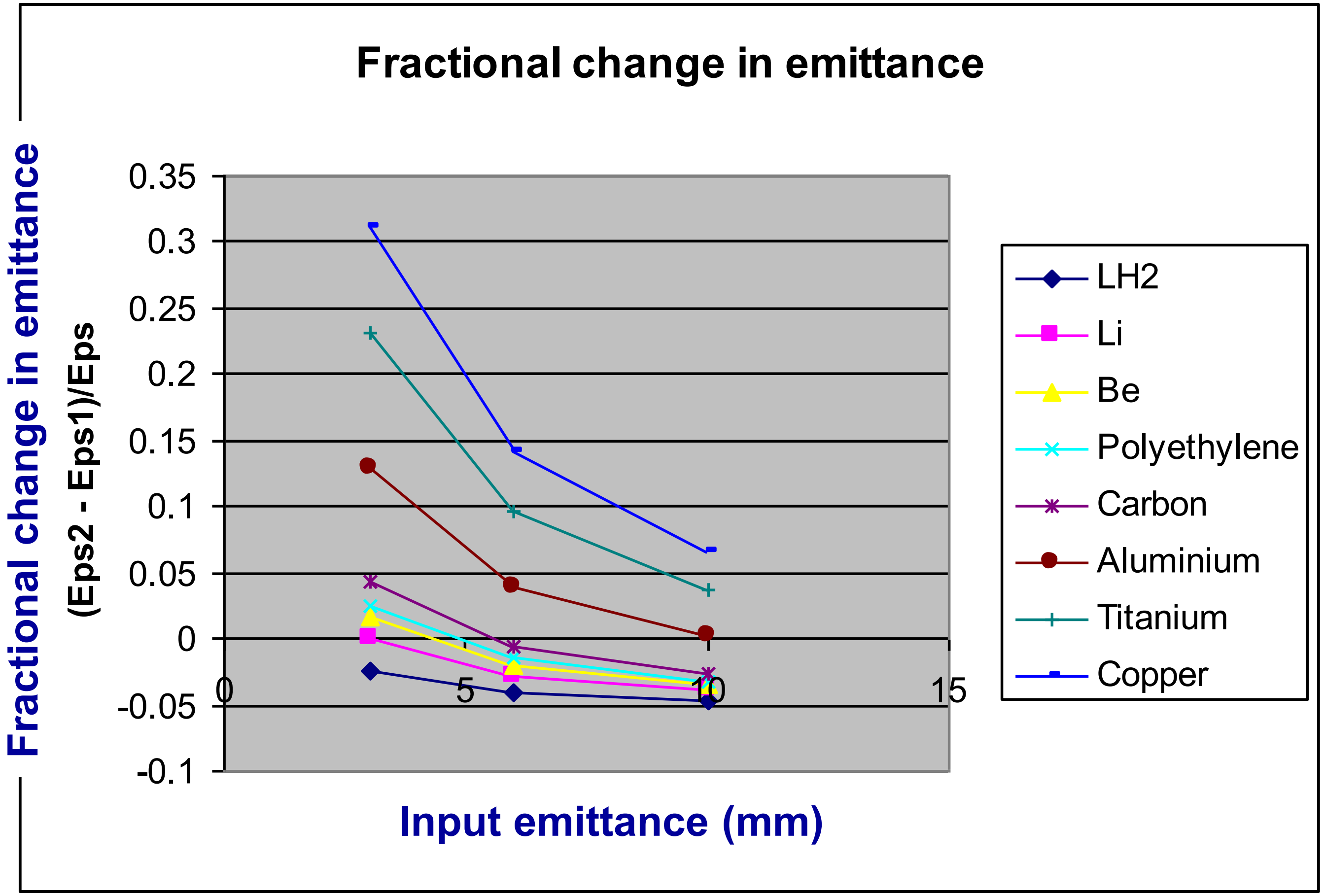


For β = 42 cm

Not sure where to plot compounds such as polyethylene

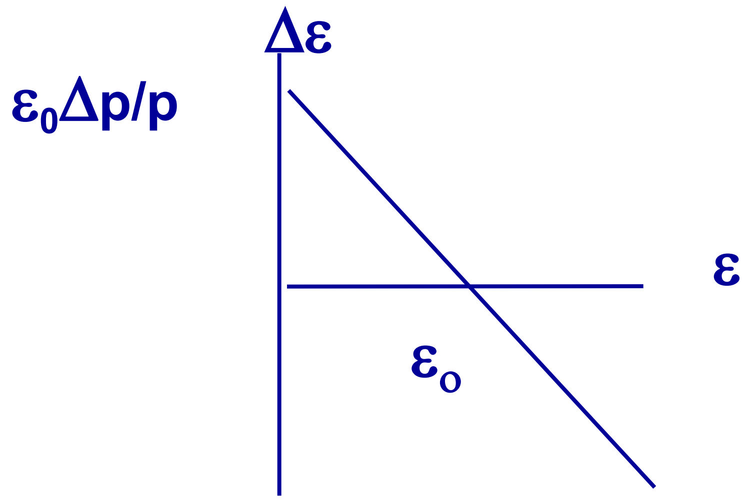
Materials up to Z ~ 12 will both cool & heat

Aluminium (Z = 13) and above will heat even a 10mm beam



We usually plot $\Delta\varepsilon/\varepsilon$ versus ε

Not necessarily the best way

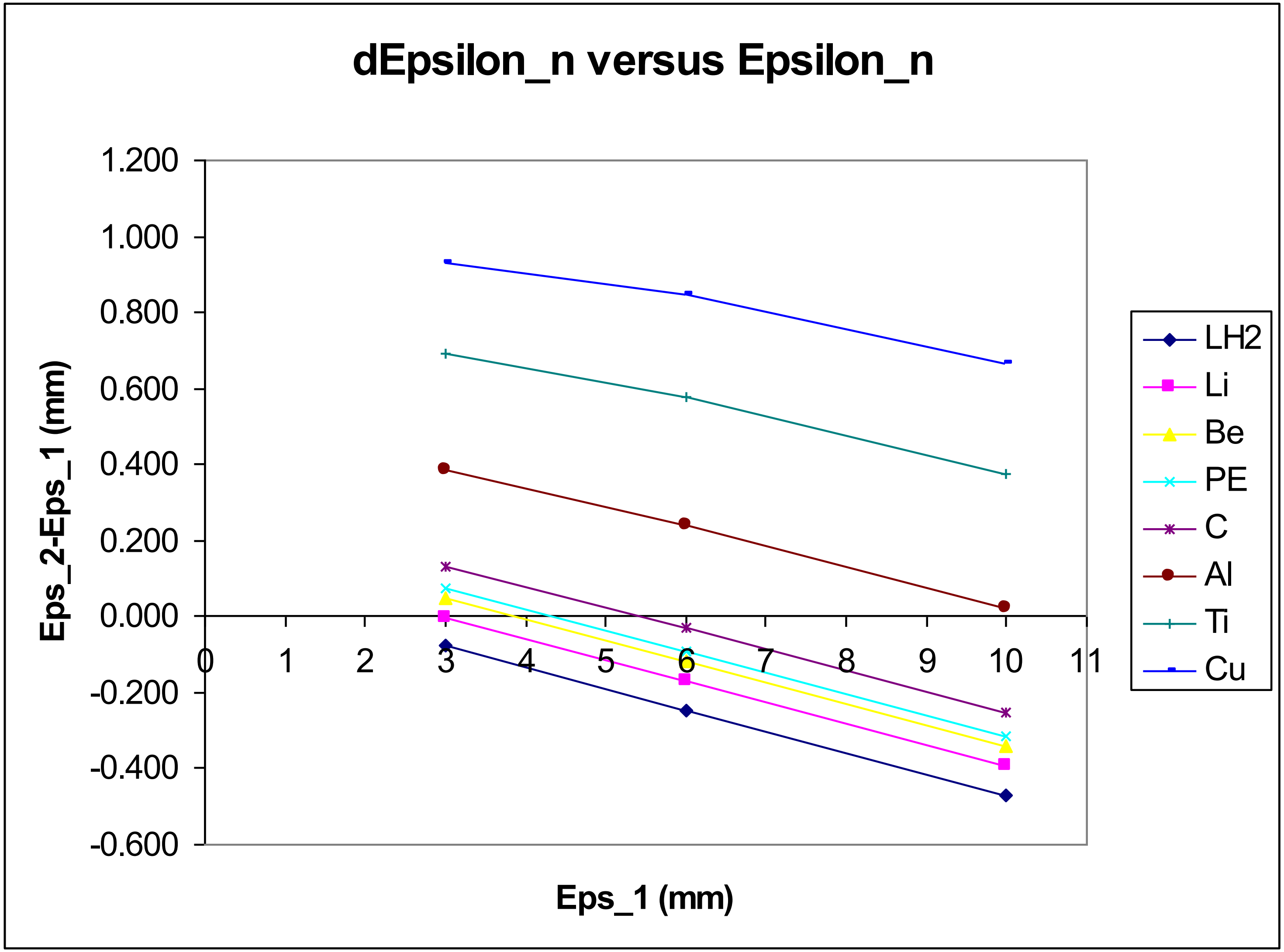


For thin absorber can write cooling formula as:

$$\Delta\varepsilon = -\,\varepsilon\,(\Delta p/p) + \varepsilon_0\,(\Delta p/p)$$

where ε_0 is equilibrium emittance

Straight line plot; intercepts give $\varepsilon_0 \Delta p/p$ and ε_0



Beta = 42cm

Note that **LH_2** ***has no windows➔ bit higher***

LiH ***not shown***

COMMENTS (1)

- Be ~ Polyethylene

- Ti & Cu look a bit heavy to give useful measurement of ε_0
  - ε_0 rather high ➔ long extrapolation
  - May be other (matching) problems (see TC's talk)
  - But could be done

- Rather like Carbon because equilibrium emittance ~6mm
  - Heats 3mm, does nothing to 6mm, cools 10mm beams

- (How do we know Beta at absorber?
  - Evolve from trackers is only way)

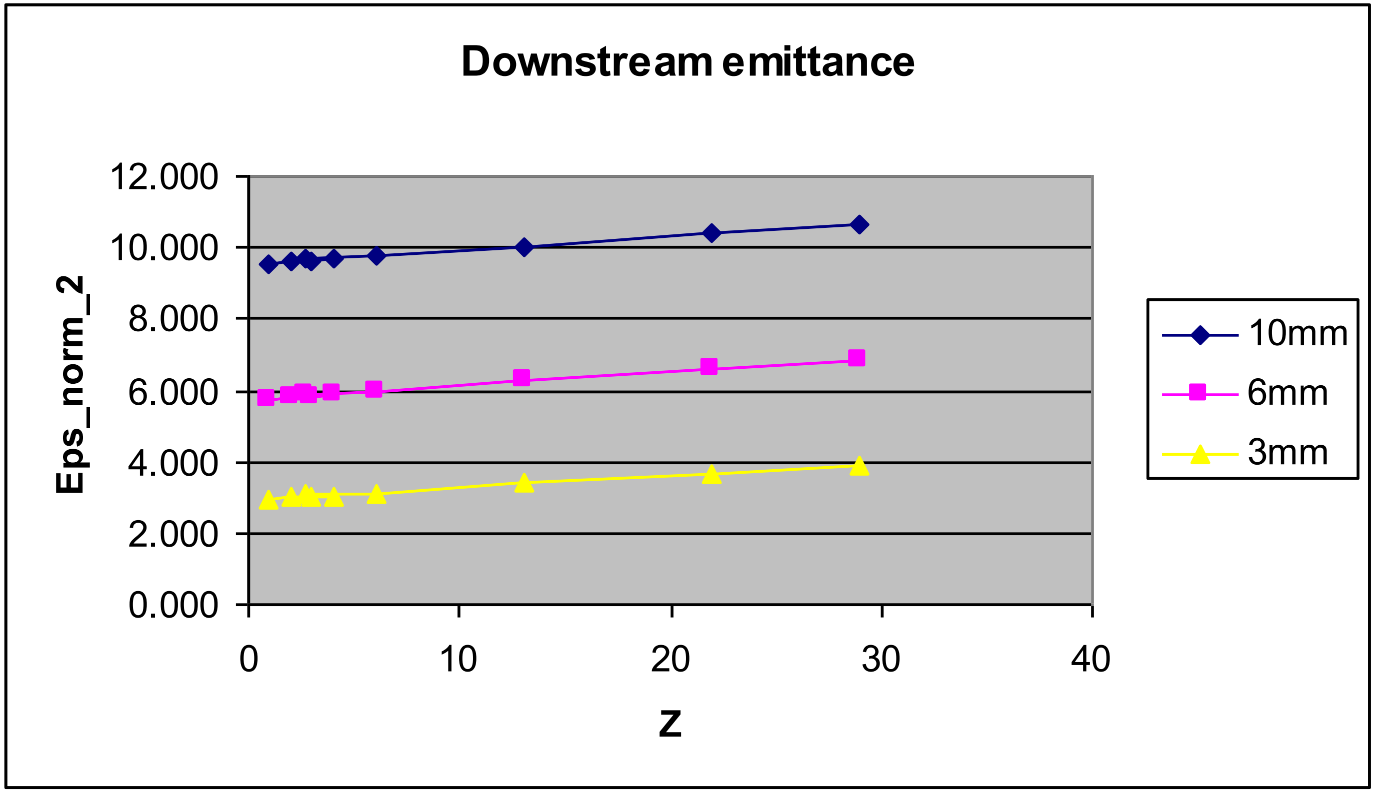
COMMENTS (2)

- *Suggest* sufficient set is LH_2, LiH, C and Al
  - Could add / use PE in place of C
  - No solid elements with 6 < *Z* < 13 except Na and Mg (*Z* = 12)
  - Compounds like PTFE?
    - Not sure what we would learn

- May be worth running with 20MeV's worth of C (or PE)
  - i.e. Twice the thickness
  - Bigger effects
    - Depends on matching into downsteam SS/Tracker-2

- If we really want to explore higher *Z*
  - Crank up magnets to reduce beta by factor ~2 or more
  - Equilibrium emittance drops by same factor
    - *Terra incognita*

THE END


Downstream emittance
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Eps_norm_2
0
10
20
30
40
z
10mm
6mm
3mm